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Bernstein's Inequality and Sharp Bounds for Concentration of Euclidean Norm

We present a new Bernstein's inequality for sum of mean-zero independent sub-exponential random variables with absolutely bounded first absolute moment. We use this to prove a tight concentration bound for the Euclidean norm of sub-gaussian random vectors. Then we apply the result to sub-gaussian random matrices on geometric sets, where the bounded first absolute moment condition comes naturally from the isotropic condition of random matrices. As an application, we discuss the implications for dimensionality reduction and Johnson-Lindenstrauss transforms. Lastly, we will talk about the possibility of extending this new Bernstein's inequality to second order chaos (Hanson-Wright inequality).